



**U.S.NRC**

UNITED STATES NUCLEAR REGULATORY COMMISSION

*Protecting People and the Environment*

# **Risk-Informed and Performance-Based Standards**

**Commissioner George Apostolakis**  
**U.S. Nuclear Regulatory Commission**

**IEEE Nuclear Power Engineering Committee**  
**Scottsdale, Arizona**  
**January 27, 2011**

**“A risk-informed approach to regulatory decision-making represents a philosophy whereby risk insights are considered together with other factors to establish requirements that better focus licensee and regulatory attention on design and operational issues commensurate with their importance to public health and safety.”**

[Commission’s White Paper, USNRC, 1999]

# Performance-Based Regulation

**“A performance-based regulatory approach is one that establishes performance and results as the primary bases for regulatory decision making, and incorporates the following attributes:**

- (1) measurable (or calculable) parameters (i.e., direct measurement of the physical parameter of interest or of related parameters that can be used to calculate the parameter of interest) exist to monitor system, including facility and licensee, performance,**
- (2) objective criteria to assess performance are established based on risk insights, deterministic analyses and/or performance history, ...”**

- **General Design Criterion 3 requires:**
  - minimizing probability and consequences of fires,
  - use of non-combustible material to the extent practical,
  - availability of suppression and detection systems,
  - minimal impact on safety systems in the event of fire protection system failures.
- **Browns Ferry Fire contributed to near core damage (March 22, 1975)**

# **Fire Protection (1): Appendix R 10 CFR 50 (1981)**

- **Directed toward assuring**
  - **Plant shutdown**
  - **Core cooling**
- **Very prescriptive**
  - ✓ **Defines defense in depth for fires**
    - Prevent fires
    - Detect, control and extinguish fires
    - Protect equipment for plant shutdown and cooling
- **Many (~1000) exemptions requiring compensatory measures**

## **Fire Protection (2): Appendix R 10 CFR 50 (1981)**

- **Train separation is required**
- **Fire barriers are installed (Thermo-Lag, Hemyc, Kaowool)**
- **Thermo-Lag and Hemyc safety issues**
- **Some licensees rely on operator manual actions rather than fire barriers**
- **Over 90% of the numerous non-compliances are not risk-significant**

## **10 CFR 50.48 (c)**

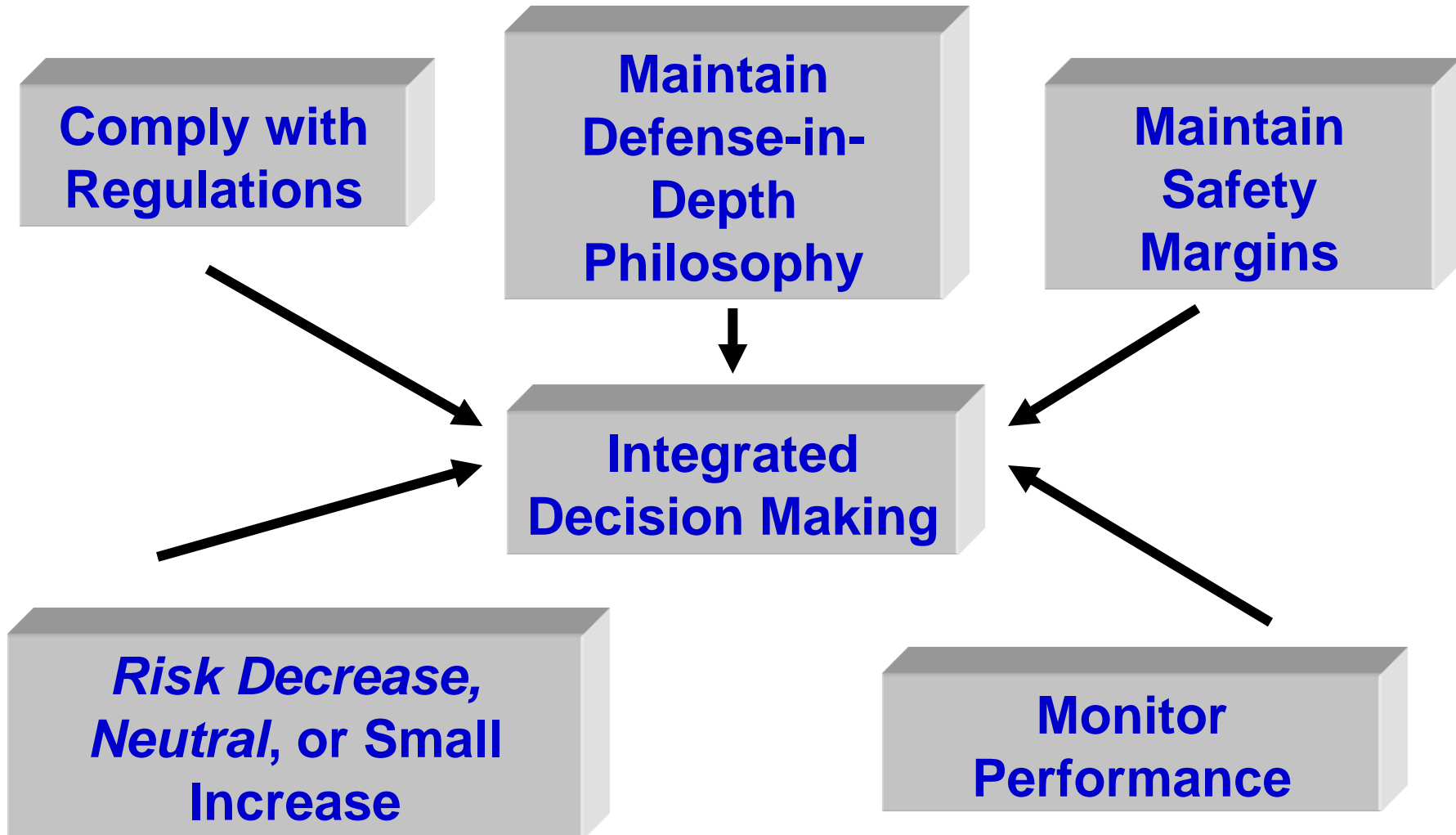
- **Approved (with some exceptions) the National Fire Protection Association Standard 805, "Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants, 2001 Edition" (NFPA 805)**
- **NRC provided enforcement discretion to provide incentives for licensees who plan to adopt NFPA 805 to self-identify and fix non-compliances**
- **Published Regulatory Guide 1.205 in support of the rule in May 2006**

## Post-Transition Activities

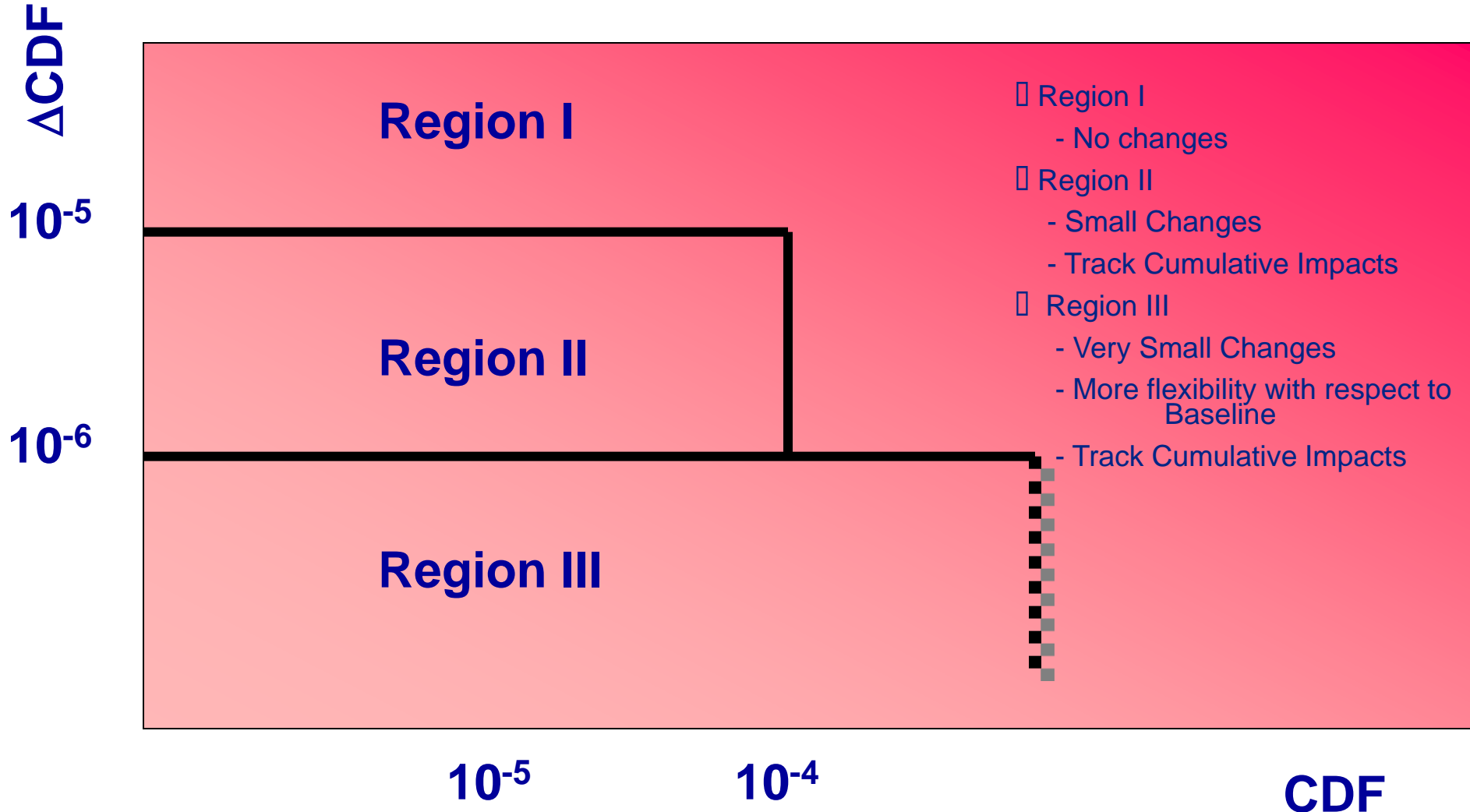
- **Following the transition to an NFPA 805 license, noncompliances are defined as deviations from Appendix R requirements until addressed**
- **Noncompliances are either corrected to satisfy Appendix R or are treated as changes to the licensing basis**
- **Any physical or programmatic change to the plant that affects the Fire Protection Program must be evaluated using a plant change process that was approved by the NRC during the license amendment request review**



## Risk-Informed Changes to the Licensing Basis (RG 1.174; 1998)



# Acceptance Guidelines for Core Damage Frequency (CDF)



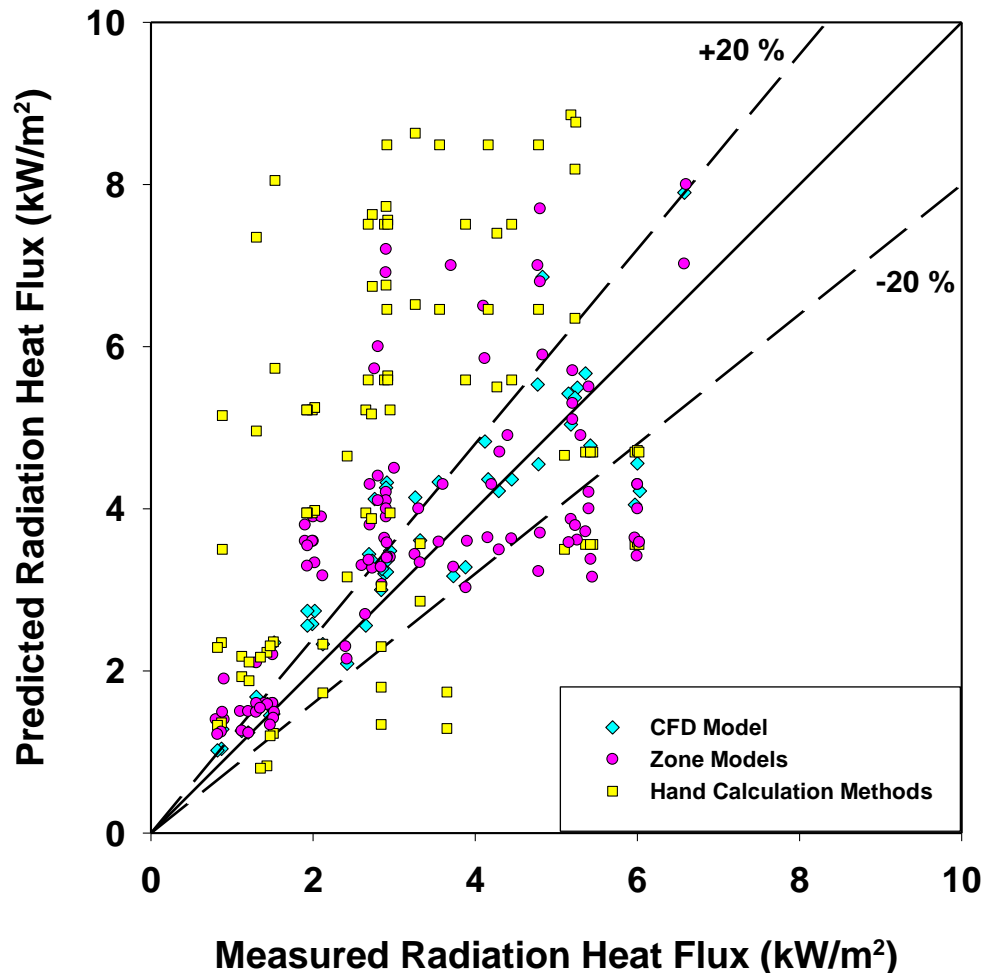
## Defense in Depth

- **The proposed change should preserve a reasonable balance among:**
  - **Preventing fires from starting**
  - **Detecting fires quickly and extinguishing those that occur, thereby limiting damage**
  - **Providing adequate level of fire protection for structures, systems and components important to safety so that a fire will not prevent essential plant safety functions from being performed**

## Safety Margins

- **Codes and standards or their alternatives accepted for use by the NRC are met, and**
- **Safety analysis acceptance criteria in the licensing basis (e.g., FSAR, supporting analyses) are met, or the licensee provides sufficient margin to account for analysis and data uncertainty**
- **Acceptable fire models are used**

# Fire Model Verification and Validation



**ASTM Standard E1355-04 “Evaluating the Predictive Capability of Deterministic Fire Models”**

**National Institute for Science and Technology**

## Risk Input (1)

- **Prior NRC review and approval is not required if the change results in a calculated risk increase less than  $1\text{E-}7/\text{yr}$  for CDF and less than  $1\text{E-}8/\text{yr}$  for large, early release frequency (LERF)**
  - **The proposed change must also be consistent with the defense-in-depth philosophy and must maintain sufficient safety margins**
- **NRC review and approval is required if the calculated risk increase for the change is  $>1\text{E-}6/\text{yr}$  for CDF or  $>1\text{E-}7/\text{yr}$  for LERF**
  - **RG 1.174 will be used as guidance in the staff's evaluation of these changes**

## Risk Input (2)

- Where the calculated plant change risk increase is  $<1\text{E-}6/\text{yr}$ , but  $\geq 1\text{E-}7/\text{yr}$  for CDF or  $<1\text{E-}7/\text{yr}$ , but  $\geq 1\text{E-}8/\text{yr}$  for LERF, the licensee must submit a summary description of the change to the NRC following completion of the change evaluation
  - The proposed change must also be consistent with the defense-in-depth philosophy and must maintain sufficient safety margins
  - If the NRC does not object to the change within 90 days, the licensee may proceed with implementation of the proposed change